DOCUMENT RESUME

ED 130 488 EC 091 799

AUTHOR Holloway, Judith Lynn
TITLE An Analysis of the Visual and Auditory Aspects of Sound Blending Including Central Auditory Integration as Measured on the Maid. Final Report.
INSTITUTION New Mexico State Univ., Las Cruces.
SPONS AGENCY Bureau of Education for the Handicapped (DHEW/OE), Washington, D.C.
BUREAU NO H01835J
PUB DATE Jul 76
GRANT G-00-74-07460
NOTE 53p.

EDRS PRICE MF-$0.83 HC-$3.50 Plus Postage.
DESCRIPTORS *Aural Stimuli; *General Education; *Phonemes; Research Projects; *Speech Skills; *Visual Stimuli

ABSTRACT

Analyzed was the performance of 30 children with normal reading and speech skills on various blending tasks. There were three groups of ten Ss each with each group receiving one of three modes of presentation: auditory, visual, or auditory visual. The stimuli consisted of 150 consonant-vowel (CV), vowel-consonant (VC), and consonant-vowel-consonant (CVC) syllables. CVCs were all familiar words; CVs were all nonsense words and VCs were either real or nonsense words. In the auditory mode, sound segments representing the phonemes of the syllables were spoken at stimulus onset asynchrony (SOA) times of 500, 750, and 1000 milli-second; in the visual mode, letters corresponding to the phonemes of the syllables were projected serially at the same SOA times; and in the audio-visual mode, letters and sound segments were presented concurrently. Ss responded by speaking the syllable which had been presented in segments. Results indicated a significant effect for mode of presentation, with auditory-visual yielding the most and auditory the fewest correct responses. Syllable type also had a significant effect; CVCs presented in two segments (C-VC or CV-C) were easier than C-V, V-C, or C-V-C. Meaning and rate of presentation did not have a clear effect on performance. (Author/SBH)

**********
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
**********

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

ED130488

EC 1/4

FINAL REPORT

Project No. H0183SJ

# AN ANALYSIS OF THE VISUAL AND AUDITORY ASPECTS OF SOUND BLENDING INCLUDING CENTRAL AUDITORY INTEGRATION AS MEASURED ON THE MAID

James C. Moore & Leslie W. Dalton
Project Directors

New Mexico State University
Las Cruces, New Mexico

July 1976

U.S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

Office of Education
Bureau of Education for the Handicapped

EC091799

# AN ANALYSIS OF THE VISUAL AND AUDITORY ASPECTS OF SOUND BLENDING

BY

JUDITH LYNN HOLLOWAY, B.A.

A Thesis submitted to the Graduate School
in partial fulfillment of the requirements
for the Degree
Master of Arts

Major Subject: Speech

New Mexico State University
Las Cruces, New Mexico

August 1975

ACKNOWLEDGEMENTS

The author would like to express her gratitude and appreciation to her advisor, Dr. James Moore, whose guidance and support made this study possible. The author wishes to thank Dr. Leslie Dalton for his help with the design and construction of the experimental equipment. While claiming the shortcomings of this research as her own, the author is indebted to Dr. Warren Teichner and Richard Kelly for their invaluable assistance with questions of experimental design and statistical analysis. Finally, the author is especially grateful to Dr. Edgar Garrett for his interest and advice through this study.

This research was conducted with assistance from the Office of Education (Handicapped) under Grant No. G007407460.

VITA

November 20, 1942 - Born at Oakland, California

1964 - B.A., University of Redlands, Redlands, California

1965 - California Standard Secondary Teaching Credential, University of California, Berkeley, California

1967 - 1970 - Teacher, New York Public Schools

1970 - 1973 - Teacher, Bronx Children's Psychological Hospital, The Bronx, New York

1974 - Graduate Assistant, Department of Speech, New Mexico State University

1974 - 1975 - VSOEO Trainee, Department of Speech, New Mexico State University

ABSTRACT

AN ANALYSIS OF THE VISUAL AND AUDITORY
ASPECTS OF SOUND BLENDING

BY

JUDITH LYNN HOLLOWAY, B.A.

Master of Arts in Speech

New Mexico State University

Las Cruces, New Mexico, 1975

Doctor James C. Moore, Chairman

This study analyzed the performance of 30 children with normal reading and speech skills on various blending tasks. There were three groups of ten subjects each, and each group received one mode of presentation: auditory, visual, or auditory-visual. The stimuli consisted of 150 consonant-vowel (CV), vowel-consonant (VC) and consonant-vowel-consonant (CVC) syllables. CVCs were all familiar words; CVs were all nonsense words and VCs were either real or nonsense words. In the auditory mode sound segments representing the phonemes of the syllables were spoken at stimulus onset asynchrony (SOA) times of 500, 750, and 1000 milli-second (msec); in the visual mode letters

corresponding to the phonemes of the syllables were projected serially at the same SOA times; and in the audio-visual mode letters and sound segments were presented concurrently. Subjects responded by speaking the syllable which had been presented in segments. Results indicated a significant effect for mode of presentation with auditory-visual yielding the most and auditory the fewest correct responses. Syllable type also had a significant effect; CVCs presented in two segments (C-VC or CV-C) were easier than C-V, V-C or C-V-C. Meaning and rate of presentation did not have a clear effect on performance. The results are discussed in terms of implications for testing blending skills of children with reading or articulation disorders.

TABLE OF CONTENTS


Page

LIST OF TABLES . . . . . ix

LIST OF FIGURES . . . . . ix

INTRODUCTION . . . . . 1

Overview . . . . . 1

Review of Literature Pertinent to this Study . . . . . 3

Mode of presentation . . . . . 5

Rate of presentation . . . . . 6

Phonological and linguistic variables . . . . . 7

Real words, nonsense words, word familiarity . . . . . 9

METHOD . . . . . 12

Subjects . . . . . 12

Materials . . . . . 12

PROCEDURES . . . . . 17

Pretest Training . . . . . 17

Testing . . . . . 18

Analysis . . . . . 19

RESULTS . . . . . 20

Effect of Order . . . . . 20

Effect of Presentation Mode . . . . . 20

Effect of Syllable Type . . . . . 20

Effect of Rate of Presentation . . . . . 22

Effect of Read Word vs. Nonsense . . . . . 25

Page

RESULTS (Continued)

Qualitative Analysis. . . . . 25

DISCUSSION. . . . . 28

REFERENCES. . . . . 31

APPENDIX A: Stimulus List: CVCs . . . . . 36

APPENDIX B: Stimulus List: CVs. . . . . 38

APPENDIX C: Stimulus List: VCs. . . . . 40

APPENDIX D: Order of SOA and Syllable Type . . . . . 42

## LIST OF TABLES

Table — Page

1. Pair-Wise Comparison of Syllable Types . . . . . 23
2. Syllable Type X Mode . . . . . 23

## LIST OF FIGURES

Figure

1. Schematic Spectrogram of the Syllable /bæ g/ . . . . . 4
2. Effect of Syllaole Type X Presentation Mode ($p<.01$). . . . . 21
3. Effect of SOA X Presentation Mode (Not Significant). . . . . 24

# INTRODUCTION

## Overview

There is general agreement that reading is vitally related to speaking and listening, but the nature of the relationship is far from determined. Mattingly (1972) has pointed out the pervasive assumption that listening and reading have an analogous relationship. This assumption has been expressed by Fries (1962):

> Learning to read...is not a process of learning new or other language signals than the child has already learned. The language signals are all the same. The difference lies in the medium through which the physical stimuli make contact with his nervous state [p. xv].

Mattingly (1972) argues that viewing reading and listening as analogous activities does not satisfactorily explain the differences between them, including the fundamental difference that "listening is easy and reading is hard" (Liberman as cited by Kavanaugh, 1968, p. 119). Mattingly's (1972) view is that:

> [while] listening and speaking are primary linguistic activities; reading is a secondary...activity that relies critically upon the reader's awareness of these primary activities [p. 133].

An understanding of auditory blending skill would seem to aid in an understanding of the relationship of reading, speaking and listening since it requires the special awareness of primary linguistic activity that Mattingly (1972) has proposed as critical for reading (Savin, 1972). In addition, it is a skill related to reading performance and articulation disorders in children (Van Riper, 1954), and

reading and articulation problems are, in turn, related to each other (Winitz, 1969).

Blending skill was investigated in the present study. Since there is little agreement in the literature about the terminology appropriate in discussing the task, it may be helpful to begin with a description of the task and a clarification of terms as they are used in this study.

In the most usual form of the blending task, the subject listens to sounds which represent the phonemes of a word and responds by saying the word; for example, the subject hears the sounds /bə/, /æ/, and /də/ and responds by saying /bæd/. Confusion in discussions of the task results from lack of agreement on suitable terminology for the stimulus sounds that represent the phonemes and for the process of arriving at a correct response.

The stimulus sounds are usually referred to as phonemes in isolation, sounds in isolation, or separated phonemes (Coleman, 1970; Young and Lindsley, 1970). These terms, when unqualified, seem to ignore the relationship of phonemes and syllables. Cole's (1973) view of this relationship is that "syllables cannot exist without reference to phonemes, and phonemes are not processed except in syllable context [p. 38]" and Ladefoged (1967) has stressed that "no one...can utter anything less than a syllable [p. 148]." In this study the term for the sound to be blended will be sound segment with the understanding that there is, as a rule, no way to segment the acoustic signal into phoneme-sized segments (Studdert-Kennedy, 1974).

A number of terms have been used to describe the process of

arriving at the correct response in a blending task. The list includes integration, synthesis, resynthesization, assembly, reassembly, and fusion (Mulder and Curtin, 1955; Roswell and Natchez, 1971; Shriner and Daniloff, 1970). None of these terms seems any more descriptive of the process than does the old-fashioned term blending, but the proliferation of terms does point out that we do not have a coherent description of the task.

The complexity of the task (which will be called blending in this study) becomes clear when the nature of the speech code is considered. Liberman, Mattingly, and Turvey (1972) have emphasized that the central characteristic of the speech code is that the "consonant is truly encoded in the vowel [p. 314]." They used a schematic spectrogram of the syllable /bæg/ (see Figure 1) to illustrate the way in which information about the successive phonetic segments is carried simultaneously in the acoustic signal. Roughly the first third of the spectrogram carries information about the initial consonant and the vowel; the middle third carries information about the vowel and both consonants; and the final third carries information about the vowel and the final consonant. This brief example of the effect of encoding (see also Cooper, 1972; Liberman, 1970) may help to clarify the nature of the blending task and to suggest that the stimuli must be radically reorganized by the subject before he arrives at a correct response.

## Review of Literature Pertinent to this Study

Auditory blending has long been considered an important skill for reading. As early as 1932 Monroe devised a 15-item test of blending

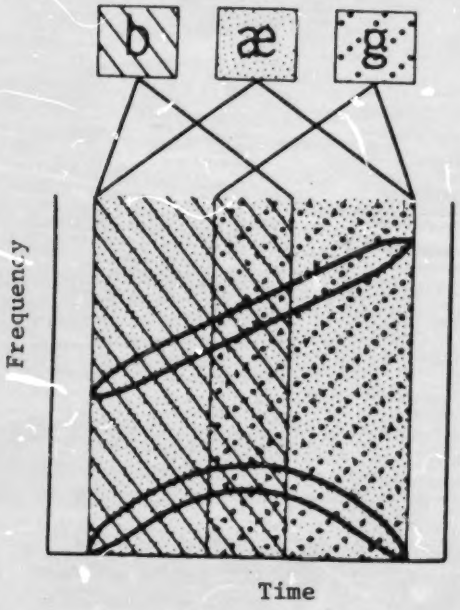


Figure 1. Schematic Spectrogram of the Syllable /bæg/

Source: Liberman, A. M., Mattingly, I. G., and Turvey, M. T. Language codes and memory codes. In A. W. Melton and E. Martin (eds.), Coding processes in human memory. New York: John Wiley, 1972.

skill and found that a reading-defect group did significantly poorer on the test than a control group (Monroe, 1932). Since Monroe there have been several studies of auditory blending as it relates to reading performance. Reynolds (1953) and Mulder and Curtin (1955) found a positive relation between silent reading ability and auditory blending in fourth grade children. Chall, Roswell and Blumenthal (1963) found auditory blending ability to be positively correlated with oral and silent reading ability in grades one through four. Hardy, Sennet and Smythe (1973) studied auditory blending and its apparent correlate, auditory segmentation, and found auditory blending to be more highly related to reading-like tasks and to reading achievement that was

auditory segmentation.

Recently, investigators have looked at the task of auditory blending apart from its relation to reading achievement with the purpose of finding out more about the task and the variables which affect it. Their studies have been concerned with the effect of rate of presentation of the stimuli (Beasley and Beasley, 1973; Shriner and Daniloff, 1970), the effect of meaning, nonsense and word familiarity (Beasley and Beasley, 1973; Laumbach, 1968; Shriner and Daniloff, 1970), and the effect of phonological and linguistic characteristics of the stimuli (Brown, 1971; Coleman, 1970; Laumbach, 1968). The present study was designed to further investigate these variables across three modes of presentation: auditory, visual and auditory-visual combined. Review of the literature relating more specifically to these topics follows.

Mode of presentation. In the studies reviewed, tests of blending ability used only auditory stimuli, either sounds spoken by the experimenter or sounds recorded and played for each subject. In addition to this typical presentation, Reynolds (1953) used a measure of blending ability obtained from a silent reading diagnostic test. Here, the mode of presentation was visual, but apparently the task was no different from a word recognition task.

Visual perception of letters and words has been studied extensively (see Smith and Spoehr, 1974, for a review), but no study was found which used visual stimuli in a way analogous to the auditory blending task, i.e., serial presentation of graphemes having a one-to-one

correspondence with the phonemes of a word. Studies have shown, however, that serial presentation of the letters of a familiar word makes the word extremely difficult to recognize (Kolers and Katzman, 1966; Newman, 1960). Kolers and Katzman (1966) found, for instance, that better than a quarter of a second exposure for each letter was necessary for accuracy of recall when six-letter words were presented serially. Other studies (Reicher, 1969; Wheeler, 1970) have found that recognition accuracy is poorer for a letter presented alone than for the same letter in a word. Although these studies are not parallel to the auditory blending task, they tend to support the assumption that serial presentation of letters would sufficiently disrupt the normal processes of word recognition so that a blending task with visual stimuli would be different from a word recognition task.

No studies were found of blending-like tasks using a combination of auditory and visual stimuli, but studies of other verbal response tasks suggest an advantage for a combined auditory-visual presentation over either auditory or visual stimuli alone. In tasks which required the naming of digits (Greenwald, 1970), it was found that when the stimulus was presented to eye and ear concurrently the speed at which subjects could name the digit increased. This was true even though subjects were instructed to ignore all auditory stimuli and attend only to visual stimuli or vice versa.

Rate of presentation. Prior to a 1970 study by Shriner and Daniloff, rate of presentation had not been investigated as a variable in the auditory blending task. When rate of presentation had been

specified in earlier studies, it was described variously as a silent interval between sound segments of one-quarter, one-half, or one second or a rate of one or two sounds per second. Shriner and Daniloff (1970) compared inter-phoneme intervals of 50, 100, 200 and 400 mili-seconds (msec). The phonemes comprising the 20 consonant-vowel-consonant syllables (CVCs) used in their blending test were recorded separately, spliced out, and blank tape was spliced between sound segments to create the specified silent intervals. They found that rate of presentation controlled by inter-phoneme silent intervals had a significant and similar effect for first and third graders. They did not find a critical breakdown at any one interval, but there was a trend for longer silent intervals to cause fewer correct responses, especially for nonsense compared to real word CVCs.

Beasley and Beasley (1973) used the same tape as Shriner and Daniloff (1970) but omitted the 50 msec interval and added a 300 msec interval. Their subjects were Black and White inner-city lower socio-economic status children while Shriner and Daniloff's subjects had been middle-class White suburban children. Their results were similar to those of Shriner and Daniloff with the exception that they did find a critical breakdown in correct responses at 200 msec.

Phonological and linguistic variables. Studies of phonological and linguistic variables have been concerned with the distinctive features of sound segments which are easy to blend, the number of phonemes represented by the segments to be blended, and the sequence of vowels and consonants within segments. (The term "syllable type" will be used

to denote the various ways of segmenting a syllable or word which is to be blended.)

The sound segments which have been used in blending tests range from words of a sentence to single phonemes of a two-phoneme word. Word-sized segments generally present no difficulty even for very young children (Schuckers, Shriner and Daniloff, 1973). Syllable segments are also easy to blend (Brown, 1971), but phoneme segments are difficult. Brown (1971) concluded that phoneme and syllable blending "involved different linguistic concepts and therefore different blending tasks [p. 235]." This distinction between phoneme and syllable in blending tasks in predictable in view of the nature of phoneme and syllable in the speech code. Studdert-Kennedy (1974) summarizes that:

> ...despite their perceptual reality, neither phonetic segments nor thier component features have acoustic reality .... The syllable has a different status, since we may define it not only linguistically, but also in articulatory and acoustic terms [p. 2367].

The effect of four types of sound segments was studied in a blending test with preschoolers (Brown, 1971). The stimuli were four-syllable words with two syllables per sound segment (SS-SS, "macaroni"), two-syllable words with one syllable per sound segment (S-S, "baby"), one-syllable words with two phonemes per sound segment (PP-PP, "stop," "post"), and one-syllable words with one phoneme per sound segment (P-P, "she"). The one- and two-syllable sound segments were equally easy to blend, and one-phoneme segments were most difficult.

Studies with preschool children as subjects have shown that some kinds of sounds are easier to blend than others. Coleman (1970) studied 578 vowel-consonant (VC) and consonant-vowel (CV) syllables

with preschool children as subjects and rank ordered the vowels and consonants according to percentage of correct responses for each syllable type. VC syllables ending in a voiceless consonant were significantly easier than VC syllables ending in a voiced consonant. For either syllable type simple vowels were more difficult than vowels ending in offglides. These findings are in keeping with those of Laumbach (1968), who also studied VC and CV syllables with preschoolers and concluded that "the major determinants of phonic blendability were phonological [p. 14]." It should be kept in mind, however, that only two phonological contrasts, voiced-voiceless and tense-lax, entered into the distinction between easy- and hard-to-blend syllables.

CV syllables have been found more difficult than VC syllables (Coleman, 1970; Laumbach, 1968), and consonant to vowel (C-V) blends were also more difficult when vowel to consonant (V-C) and C-V breaks were compared in the four types of sound segments (SS-SS, S-S, PP-PP, P-P) studied by Brown (1971).

Real words, nonsense words, word familiarity. The terms "meaningful" and "nonmeaningful" were often used in the studies reviewed but were not used as they are currently in studies of verbal learning, i.e., some nonsense words are more meaningful than others, can be learned quicker, are judged more familiar, and elicit more associations (Underwood and Schulz, 1960). To avoid confusion, real word and nonsense word will be substituted for meaningful and nonmeaningful.

The Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy and Kirk, 1968) uses both real and nonsense words in an auditory

blending test. All real words occur before the nonsense words so the assumption seems to be that nonsense words will be more difficult although it is not likely that the last real word (/t-ɛ-l-ə-f-o-n/) is easier to blend than the first nonsense word (/l-ɛ-k/). Shriner and Daniloff (1973) compared 10 pairs of real word and nonsense CVCs which differed only by the central vowel. They found "huge differences" in correct responses favoring the real words. Third graders did slightly better than first graders with real words but not with nonsense. The authors suggest that this advantage may have been due to the increased vocabulary of the older subjects. Laumbach (1968) determined that word familiarity was not a factor in a test with preschool children which used as stimuli 293 two-phoneme, one-syllable words. In another test with preschoolers (Brown, 1971), it was predicted that the greater the size of the sound segments to be blended the easier the blending task would be. This proved to be the case except that double syllable segments (SS-SS) were no easier than single syllable segments (S-S). The author suggested that the greater "recognizability" of the double syllable segments was offset by the fact that many of the four syllable words were unfamiliar to the children.

Meaningfulness as defined operationally by Underwood and Schulz (1960), for example, has not been studied and the effect of word familiarity and of real vs. nonsense words has not been thoroughly investigated. It appears, however, that these factors may interact with both age and syllable type.

The literature indicates that rate of presentation, syllable type, real word vs. nonsense, and certain phonological characteristics

have a significant effect on the task of blending. Although interest in blending has been chiefly with reference to its importance for reading, tests of blending ability have been conducted only with auditory stimuli. The exclusive use of the auditory mode is understandable in that auditory skills have been shown to be more highly related than visual skills to reading performance (Deutsch, 1964; Hammill, 1972). Nevertheless, the reader, regardless of his auditory skills, must begin with visual stimuli.

The purpose of the present study was to further investigate three variables which had been found, under varying conditions, to have a significant effect on the task of blending: rate of presentation, syllable type, and real word vs. nonsense word. In addition, these variables were studied across three modes of presentation: visual and audio-visual in addition to the usual auditory mode.

## METHOD

### Subjects

Subjects for this study were 30 third- and fourth-grade students from Hermosa Heights School in Las Cruces, New Mexico. They were judged to be normal readers on the basis of having met the following conditions:

1. they achieved an intelligence quotient of 90 or above on the California Short Form Test of Mental Maturity;**
2. they had an obtained total reading score on the Comprehensive Test of Basic Skills, no more than one month below grade level at the time the test was last administered (March 1974);
3. they exhibited reading and speech skills appropriate for grade level as judged by their teachers; and
4. they had normal hearing and vision as tested by school personnel.

Of the students, 16 were females and 14 were males. The subjects were randomly assigned to six groups of five subjects each.

### Materials

A stimulus test was constructed of 150 items derived from a list of 30 CVC words (see Appendix A). Each CVC was segmented in three

---

** Two subjects fell slightly below this criterion but met conditions (2) through (4).

ways: C-V-C, CV-C, C-VC; C-V and V-C segments of the CVCs were also presented. For example, in the auditory mode the phonemes of the word "big" were presented as /b-I-g/, /bI-g/, /b-Ig/, /b-I/, and /I-g/. In the visual mode the letters of the word were serially presented as "b-i-g," "bi-g," "b-ig," "b-i," and "i-g." There were 30 test items for each syllable type.

Auditory and visual stimuli were selected within the following constraints as listed below.

1. The consonants were clearly audible when presented on tape. Consonants excluded as being difficult to hear on tape were /f, p, t, k, θ/ (Shriner and Daniloff, 1970). Eleven consonants were used: /b, d, g, m, n, s, ʃ, l, r, tʃ, dʒ/. The corresponding graphemes (digraphs in two cases) were: "b, d, g, m, n, s, sh, l, r, ch, j."

2. Vowels corresponded to the first vowel sounds taught in a phonic or linguistic approach to reading (Chall, 1967): /æ, ɛ, I, ʌ/ (/a/ was not used). The corresponding graphemes were "a, e, i, u."

3. There was a consistent one-to-one correspondence between phonemes and graphemes, and CVCs were excluded in the visual CV segment formed a word, for example, "be" in the word "bed."

4. All CVCs were listed in A Basic Vocabulary of Elementary School Children (Rinsland, 1945) as having occurred in the written work of third graders.

All CVCs were real words, but within the syllable types used both real and nonsense words occurred. Given the phoneme-grapheme correspondences for vowels, no real word CVs were formed. The VCs, on the other hand, were both nonsense (/æg/ in /bæg/) and real words

(/It∫/ in /rIt∫/). In order to provide a check for the effect of real word vs. nonsense, the list was partially balanced in the following way. Fifteen VCs were real words and 15 were nonsense; within the basic list of 30 CVCs, 15 VC segments were real words and 15 were nonsense. When a VC or CV segment occurred more than once in the basic 30 CVCs a replacement was chosen randomly from a list of possible VC and CV syllables. The 15 VCs which were real words auditorily were not all spelled according to conventional orthography in the visual mode; /æ d/ was spelled "ad," /ɛg/ was "eg," etc. (see Appendices B and C).

Rate of presentation was varied by stimulus onset asynchrony (SOA), the interval between the onset of one stimulus and the onset of the next. The SOAs used were 500, 75[illegible] and 1000 msec. Each list of 30 items of a given syllable type was divided into three blocks of ten items and each block was presented at one of the three SOAs.

To allow an evaluation of the effect of order of presentation, two complete stimulus lists were prepared (Program I and Program II). For each program the order of syllable types, stimulus items, and SOAs was randomly assigned (see Appendix D).

Both orderings of the stimulus list were recorded by the experimenter. Recording was done in a sound-treated room on a Scully Model 380-2, one-half track audio tape recorder with an Electrovoice Model 635-A microphone. The microphone was connected to the input of a Gates Model M-6158A Executive audiocontrol console, and the program of the console was connected to the input of a Collins Model 26U-2 limiter-amplifier. The limiter output was connected to the line input

of the left channel of the Scully. Through headphones, the experimenter heard a tone delivered at a steady rate of one tone every 500, 750 or 1000 msec. The sound segments were spoken in time with the tones, thus creating the SOA times.

This method of preparing the auditory stimuli was chosen in order to maintain a resemblance to the clinical situation. SOA was used in preference to inter-stimulus interval because, intuitively, it is difficult for a speaker to monitor silent intervals between sounds but easy to speak in time with a steady rhythm. Some lack of precision was inherent in recording each stimulus independently. Since no two phones are identical, the [b]s, for example, of [b-æ-g] and [b-I-g] were not identical. This imprecision can be avoided by recording the [b] segment only once, then dubbing and splicing it in wherever it occurs (Shriner and Daniloff, 1970). However, in the clinical situation the uniqueness of phones is unavoidable.

A 1000 Hz. tone was recorded on the right channel of the tape corresponding to the initiation of the first segment of each item on the stimulus list. This tone was used to synchronize visual and auditory stimuli.

The stimuli for the visual mode were slides of single letters, digraphs and trigraphs which corresponded to the sound segments of the auditory mode. The letters were traced with India ink on white paper using a Varigraph Headwriter and a Franklin Gothic Condensed letter template. The letters were photographed on Kodak Pantomic X film and developed as negatives so that the projected image was a light figure on a dark ground. A standard copy stand was used with a Minolta

SRT-101. To achieve maximum contrast, the film was two steps underexposed and overdeveloped accordingly in D-76 developer.

Three Sawyer Rotomatic slide projectors were adapted and used to project the slides. The exposure of the slides and the synchronization of the auditory with visual stimuli was accomplished with locally constructed timing equipment triggered by the tones on the right channel of the stimulus tape recording. As described under Procedures and Analysis, a Realistic Model 999-B tape deck, a Realistic Model FA-500 stereo amplifier, Telex Model MR-6 headphones, and a Superscope Model C-104 cassette recorder were used to present the stimuli and store data.

## PROCEDURES

### Pretest Training

A pretest training session was conducted by the experimenter with each subject. The first phase of the training was the same for all subjects. The experimenter spoke a syllable and its segmented representation. The child was asked to tell which was "together," e.g., "Which is together, /p-æ/ or /pæ/?" Using /pæt/ as the basic CVC, an example was given for each of the five syllable types occurring on the test.

The second phase of the pretest training was different for subjects in each presentation mode and was parallel to the task of the testing mode the subject was to receive. For the auditory mode, the experimenter spoke the segmented representation of the examples in phase one of the pre-test training and asked the subjects to put the segments together. For the visual mode the subjects were tested on their knowledge of phoneme correspondents for the graphemes used in the study. Errors were noted and the required responses were practiced until the subject could make three consecutive correct responses to the target grapheme interspersed with responses to two graphemes for which no error had been made originally. Graphemes corresponding to the sound segments spoken in the first phase of the pretest training were shown sequentially and the subject was told to look at the letters, think of the sounds, and put them together. For the audio-visual mode, the experimenter spoke the sound segments while showing the corresponding

graphemes. Whenever an error was made, the experimenter modeled the correct response and repeated the item. If an error was made on the second trial, the experimenter again modeled the correct response and proceeded to the next item.

Following the pretest training all subjects were told that they would perform the same task except they would listen to the sounds through earphones, or see the letters on the screen, or both, according to the mode of presentation the subject was to receive. Ten subjects were assigned to each of the three modes of presentation and within each mode, five subjects received the stimuli as ordered in Program I and five received the stimuli as ordered in Program II.

Testing

Subjects in the auditory mode listened to the experimental tapes played from a Realistic Model 999-B tape deck through a Realistic Model FA-500 stereo amplifier and Telex Model MR-6 headphones. Intensity was adjusted to a comfort level for each subject. Subjects in the visual mode saw letters projected serially at the same point on a screen approximately four feet in front of them. The letters were clearly visible and exposure time was well above the threshholds necessary for recognition (Gibson, Osser and Pick, 1963). The letters were approximately two inches in height. The SOA times were identical to those for the auditory mode and exposure times were slightly shorter than SOAs. Subjects in the audio-visual mode simultaneously listened to the sounds as described for the auditory mode and saw the letters as described for the visual mode.

A red light on a table where the subjects sat lit up concurrent with the last sound or slide in each trial and subjects were told to respond when they saw the light. There was an interval of approximately five seconds between trials and when necessary the recording was stopped to allow additional response time.

Analysis

The responses were scored correct or incorrect, and incorrect responses were recorded in broad phonetic transcription. The tests were scored by the experimenter during the testing session, and subjects' responses were also recorded on a Superscope Model C-104 cassette recorder for comparison with live scoring. A 40% sample (two subjects from each of the six groups) of recorded responses was later scored by the experimenter and correlated with the live scores to establish intra-judge reliability. Since intra-judge reliability was satisfactory ($\phi$= .92), the live scores were used in analyzing the data.

## RESULTS

### Effect of Order

Programs I and II were compared to determine if the order of presentation of stimuli affected a subject's overall performance. The measurement used was total number of correct responses for each subject. Wilcoxon's rank-sum test (Bradley, 1968) showed no significant difference between the two programs for any of the three modes of presentation ($W(5) = 25$, $p<.05$). Therefore, the data for Programs I and II were combined for subsequent analysis.

### Effect of Presentation Mode

Presentation mode was found by the Friedman analysis of variance (Bradley, 1968) to have a significant main effect ($X^2(2) = 14.6$, $p<.01$). Performance was best with the combined audio-visual presentation mode and worst with the auditory mode. Insepction of Figure 2 shows the auditory mode to be clearly poorest while visual and audio-visual modes are not so clearly different in graphic form. A Sign test (Bradley, 1968) was used to determine if any two presentation modes were, in fact, alike. A significant difference was found between visual and audio-visual modes ($p<.05$) as well as between auditory and visual or audio-visual modes ($p<.01$).

### Effect of Syllable Type

Syllable type was found to have a significant main effect ($X^2(4) = 40.533$, $p<.01$). Sign tests were used to determine: (a) what

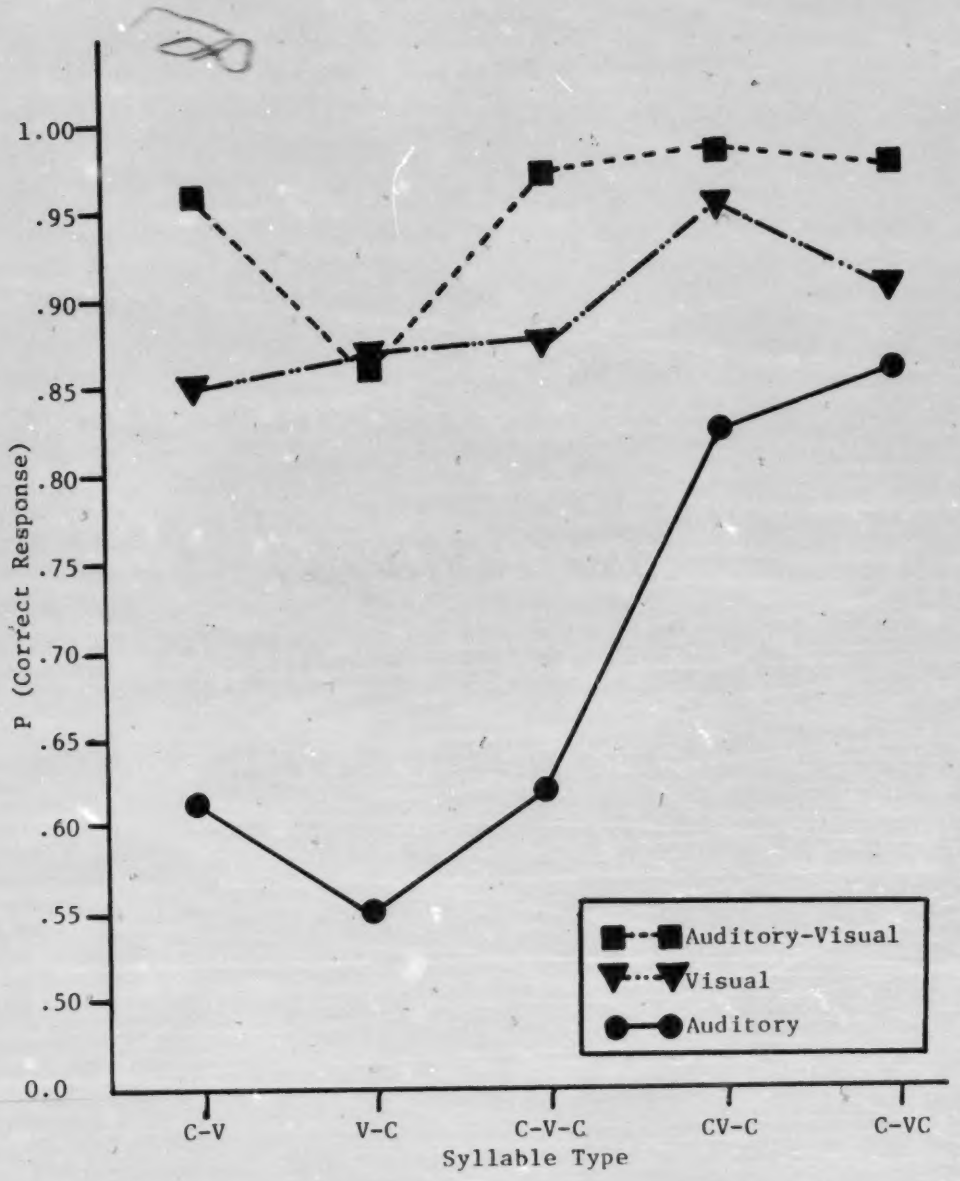


Figure 2. Effect of Syllable Type X Presentation Mode ($p<.01$)

syllable types were different across modes and (b) what syllable types were different within each mode. A summary of these tests is presented in Tables 1 and 2.

Syllable type had similar but not identical effects in different modes. The auditory mode produced the most variation with six significantly different pairs of syllable types, and the visual mode produced the least variation with only three significantly different pairs. The CV-C and C-VC syllables (ba-g and b-ag) did not differ from each other significantly in any mode. They also tended to be easiest in every mode, but they were significantly easier than all other syllable types only in the auditory mode. When the three syllable types containing one phoneme per segment (C-V, V-C, C-V-C) were compared, they differed significantly in only one instance, V-C and C-V-C were significantly different in the auditory-visual mode.

The interaction of Syllable Type X Presentation Mode was significant ($X^2(12) = 38.40$, $p<.01$). As can be seen in Figure 2, the main source of this interaction was the subjects' poor performance in the auditory mode with the three syllable types which consist of only one phoneme per sound segment (C-V, V-C, C-V-C).

Effect of Rate of Presentation

The three SOAs, 500, 750 and 1000 msec, did not have a significant main effect nor was there an interaction of SOA with mode or syllable type. As shown in Figure 3, there was a similar slight advantage for 750 msec in all modes.

Table 1. Pair-Wise Comparison of Syllable Types

| Syllable Types | Across Modes | Auditory | Visual | Audio-Visual |
|---|---|---|---|---|
| C-V vs. V-C | * | NS | NS | NS |
| C-V vs. C-V-C | NS | NS | NS | NS |
| C-V vs. CV-C | ** | * | ** | ** |
| C-V vs. C-VC | ** | * | NS | * |
| V-C vs. C-V-C | ** | NS | NS | ** |
| V-C vs. CV-C | ** | ** | ** | ** |
| V-C vs. C-VC | ** | ** | NS | ** |
| C-V-C vs. VC-C | ** | ** | * | NS |
| C-V-C vs. C-VC | ** | * | NS | NS |
| CV-C vs. C-VC | NS | NS | NS | NS |

* = p<.05
** = p<.01
NS = not significant

Table 2. Syllable Type X Mode

| Syllable Type | Auditory-Visual vs. Visual | Visual vs. Auditory | Auditory vs. Auditory-Visual |
|---|---|---|---|
| C-V | * | * | * |
| V-C | ** | ** | ** |
| C-V-C | ** | * | * |
| CV-C | NS | ** | ** |
| C-VC | NS | NS | NS |

* = p<.05
** = p<.01
NS = not significant

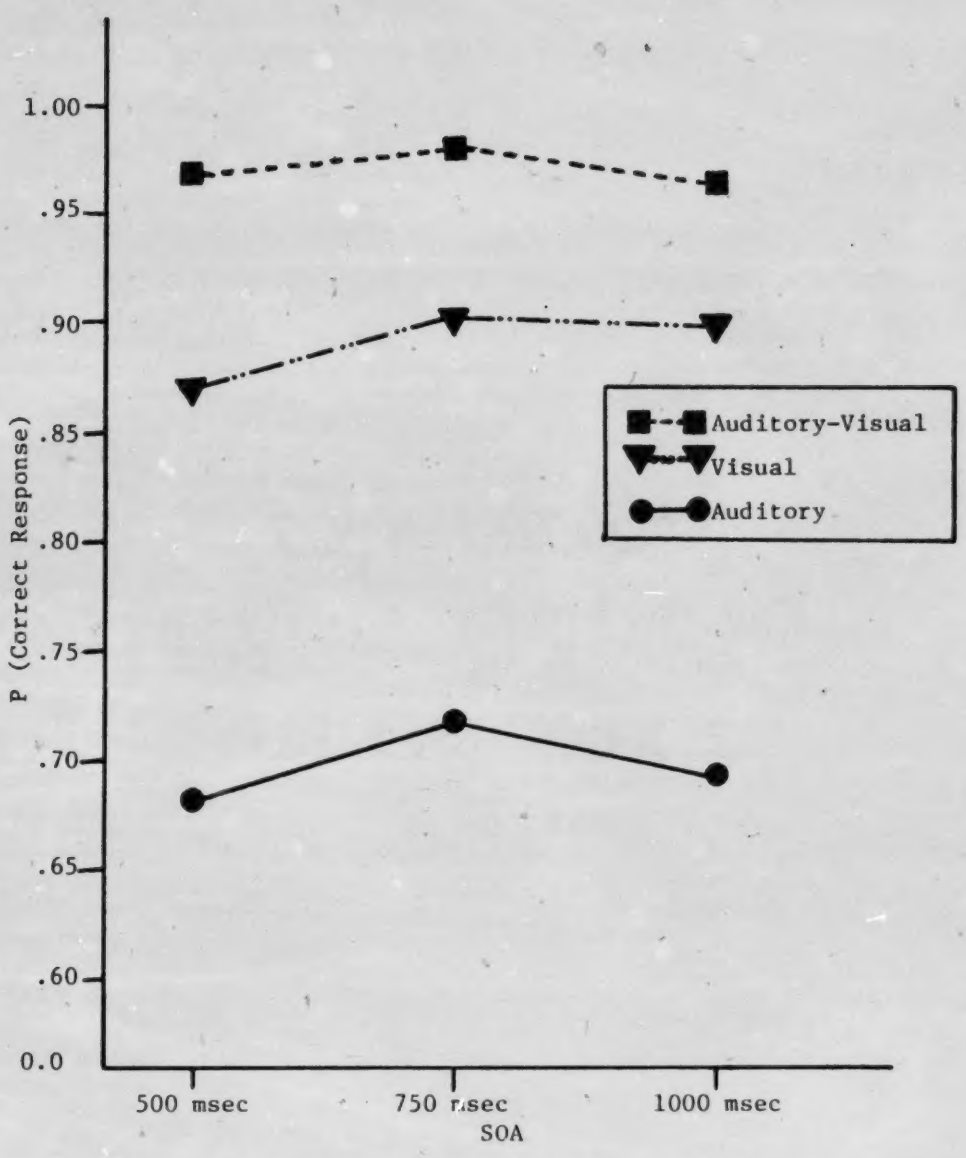


Figure 3. Effect of SOA X Presentation Mode (Not Significant)

Effect of Real Word vs. Nonsense

As described in the section on materials, there were four syllable types where real word vs. nonsense might have an effect: V-C, C-V-C, CV-C, and C-VC. When these four syllable types were considered together the effect of a real vs. a nonsense word as the VC segment was not significant ($X^2(6) = 1.40$, NS). A Sign test for real word vs. nonsense in the VC list alone showed an advantage for nonsense over real words ($p<.05$).

Qualitative Analysis

For the purposes of statistical analysis all responses were scored as correct or incorrect, but among the incorrect responses the types of errors that occurred were of interest. The errors could be grouped into two main categories: (a) errors that indicated a failure to understand the task, and (b) errors that indicated perceptual confusion or a failure to use the correct phoneme-grapheme correspondence. For convenience, these will be referred to as (a) blending errors and (b) nonblending errors.

Errors such as /sæt/ for /sæd/ in the auditory mode, /dIg/ for bIg/, and /lɛdʒ/ for /lɛg/ in the visual mode were considered nonblending errors. This type of error accounted for 60% of the total error--56% in the auditory mode, 79% in the visual mode, and 60% in the auditory-visual mode. (In the auditory-visual mode one subject was the source of 30% of the error, and that subject's responses were excluded in figuring the percentage of error types.)

In the auditory mode the most frequent consonant confusion was

the substitution of a voiceless stop for its voiced cognate, /p/ for /b/, /t/ for /d/, and /k/ for /g/. Nearly all the vowel confusions occurred with /I/ and /ɛ/; /I/ was most often reported as /ɛ/; /ɛ/ was most often reported as /æ/. These errors are consistent with the relative positions of /I/, /ɛ/, and /æ/ on the physiological vowel diagram (Carrell and Tiffany, 1960).

With visual stimuli the most frequent nonblending error was the confusion of "b" and "d"; errors included "dad," "dab," and "bab" for "bad." Use of the wrong phoneme-grapheme correspondence occurred almost exclusively with the vowels and "g," letters which have more than one phoneme correspondent in the general orthography. There was no noticeable pattern of errors with the vowels; the error with "g" was always /dʒ/ as with /dʒʌm/ for /gʌm/.

Vowel confusion accounted for nearly all nonblending errors in the auditory-visual mode, and again no pattern of error was apparent. The combination of auditory and visual stimuli all but eliminated consonant confusions.

Blending errors accounted for 40% of the total error and several types of errors fell under this general category:

1. failures to respond, perseverative and anomalous responses;
2. sequential errors, /In/ for /nI/;
3. repetition of only one of the sound segments to be blended, /də/ for /dIg/;
4. additions, /dʒæm/ for /dʒæ/, /IntʃI/ for /ItʃI/, /bIdIn/ for /bIn/;
5. two-syllable responses containing a schwa or syllabic

/bæ gə/ for /bæ g/, /rʌnə/ for /rʌn/.

The last type of error was overall the most frequent blending error and occurred in all modes, but particularly in the auditory mode where it accounted for 48% of the blending errors. In the visual mode this error type accounted for 11% of the blending errors, and in the auditory-visual mode (excluding data from one subject) for 33% of the blending errors.

## DISCUSSION

In this study of auditory, visual and auditory-visual blending tasks, modality was found to have a significant effect. Of the variables investigated across modality groups, syllable type was significant while rate of presentation and real vs. nonsense words did not have a decisive effect on performance.

The non-significant effect of rate of presentation seems to indicate that for a clinically administered blending test, rate is not a critical factor. There was a slight advantage for a 750 msec SOA which was, subjectively, the most comfortable speaking rate.

The finding that nonsense VCs were significantly easier than real word VCs should probably be regarded as an indication that other factors were involved such as phonological characteristics of the stimuli and meaningfulness as it is defined operationally by Underwood and Schulz (1960).

When syllable types were compared, an advantage was found for those with a two-phoneme sound segment (CV-C, C-VC) over those with only one-phoneme sound segment (C-V, V-C, C-V-C). An unexpected result was that there was no difference among the syllable types that contained only one-phoneme sound segments. The advantage for VC over CV syllables found with preschoolers (Brown, 1971; Coleman, 1970; Laumbach, 1968) was not found with the third graders in the present study. A possible explanation is that phonological awareness, and therefore the effect of phonological variables, changes with age

(Chomsky, 1970; Read, 1971) or reading may provide beneficial practice with the consonant-to-vowel blends. The C-V-C syllable type was no more difficult than C-V or V-C although it requires memory for three items rather than two and seems to require two blending processes rather than one.

When modality groups were compared, performance was best for auditory-visual, slightly poorer for visual, and clearly poorest for auditory presentation. Modality affected not only the number of errors but the types of errors made as well.

In the auditory mode and to a lesser extent in the auditory-visual mode a typical error was a two-syllable response including a schwa or syllabic (/bægə, bIŋ/). This type of error did not occur in the visual mode. (Two subjects receiving the visual mode made technically similar errors which included a schwa--/təʃæ / for /tʃæ/.) Judging from the errors made in the visual mode the subjects appeared to perform much as they would have for a word recognition test. Subjects in the auditory-visual mode appeared to use the auditory stimuli to advantage for clarification of visually confusing letters ("b" and "d") and of letters which are associated with more than one sound in the general orthography (the vowels and "g").

Given the results obtained with normal third-grade subjects, a similarly designed blending test would seem to be helpful in assessing the skills of children who have reading and/or articulation problems and of younger children who are just beginning to learn to read. It is suggested that a comparison of children with articulation problems and children with reading problems might also provide information

about the way in which reading, speaking, and listening are related.

The results of the present study suggest the following revised format for subsequent tests of blending skill:

1. three modes of presentation, auditory, visual, and auditory-visual, should be used to present the stimuli;

2. a variety of syllable types should be included; the syllable types V-C, C-V-C, and CV-C are suggested since, in the present study, they were most often significantly different in comparisons within and across modes;

3. while not a critical factor, a rate of presentation corresponding to a 750 msec SOA would appear to be optimal; and

4. comparisons of real and nonsense words should take into full account the phonological characteristics and meaningfulness of the stimuli.

## REFERENCES


Beasley, D. S. and Beasley, D. C. Auditory reassembly abilities of black and white first- and third-grade children. Journal of Speech and Hearing Research, 1973, 16, 213-221.

Bradley, J. V. Distribution-free statistical tests. Englewood Cliffs, N. J.: Prentice-Hall, 1968.

Brown, D. L. Some linguistic dimensions in auditory blending. In F. P. Greene (ed.), Reading: The right to participate. Milwaukee: National Reading Conference, 1971.

Carrell, J. and Tiffany, W. R. Phonetics: Theory to speech improvement. New York: McGraw-Hill, 1960.

Chall, J. S. Learning to read: The great debate. New York: McGraw-Hill, 1967.

Chall, J., Roswell, F. G. and Blumenthal, S. H. Auditory blending ability: A factor in success in beginning reading. Reading Teacher, 1963, 17, 113-118.

Chomsky, N. Phonology and reading. In H. Levin and J. P. Williams (eds.), Basic studies in reading. New York: Basic Books, 1970.

Cole, R. A. Perceiving syllables and remembering phonemes. Journal of Speech and Hearing Research, 1973, 16, 37-47.

Coleman, E. B. Collecting a data base for reading technology. Journal of Educational Psychology Monograph, 1970, 61 (4, Pt. 2), 1-23.

Cooper, F. S. How is language conveyed by speech? In J. F. Kavanaugh and I. G. Mattingly (eds.), Language by ear and by eye. Cambridge, Mass.: MIT Press, 1972.

Deutsch, C. P. Auditory discrimination and learning: Social factors. Merrill-Palmer Quarterly, 1964, 10, 277-296.

Fries, C. C. Linguistics and reading. New York: Holt, Rinehart and Winston, 1962.

Gibson, E. J., Osser, H. and Pick, A. D. A study of the development of grapheme-phoneme correspondences. Journal of Verbal Learning and Verbal Behavior, 1963, 2, 142-146.

Greenwald, A. G. A double stimulation test of ideomotor theory with implications for selective attention. Journal of Experimental Psychology, 1969, 84, 392-398.

Hammill, D. Training visual perceptual processes. Journal of Learning Disabilities, 1972, 5, 552-559.

Hardy, M., Sennett, R. G. and Smythe, P. C. Auditory segmentation and auditory blending in relation to beginning reading. Alberta Journal of Educational Research, 1973, 19, 144-158.

Kavanaugh, J. F. (ed.) The reading process: Proceedings of the conference on communicating by language. Bethesda, Md.: National Institute of Child Health and Human Development, 1968.

Kirk, S. A., McCarthy, J. J. and Kirk, W. D. Illinois test of psycholinguistic abilities: Revised ed. Urbana: University of Illinois, 1968.

Kolers, P. A. and Katzman, M. T. Naming sequentially presented letters and words. Language and Speech, 1966, 9, 84-95.

Ladefoged, P. Three areas of experimental phonetics. London: Oxford University Press, 1967.

Laumbach, J. D. Rank-ordering two-sound words as to phonic blendability. Unpublished masters thesis, University of Texas at El Paso, 1968. Cited by E. B. Coleman, Collecting a data base for reading technology. Journal of Educational Psychology, 1970, 61(4, Pt. 2).

Liberman, A. M. Some characteristics of the speech mode. In D. A. Hamburg, K. H. Pribram and J. J. Stunkard (eds.), Perception and its disorders. Baltimore: Williams and Wilkins, 1970.

Liberman, A. M., Mattingly, I. G. and Turvey, M. T. Language codes and memory codes. In A. W. Melton and E. Martin (eds.), Coding processes in human memory. New York: John Wiley, 1972.

Mattingly, I. G. Reading, the linguistic process, and linguistic awareness. In J. F. Kavanaugh and I. G. Mattingly (eds.), Language by ear and by eye. Cambridge, Mass.: MIT Press, 1972.

Monroe, M. Children who cannot read. Chicago: University of Chicago Press, 1932.

Mulder, R. V. and Curtin, J. T. Vocal phonic ability and silent reading achievement: A first report. Elementary School Journal, 1955, 56, 121-123.

Newman, E. B. Speed of reading when the span of letters is restricted. American Journal of Psychology, 1966, 79, 272-278.

Read, C. Preschool children's knowledge of English phonology. Harvard Educational Review, 1971, 41, 1-34.

Reicher, G. M. Perceptual confusion as a function of meaningfulness of stimulus material. Journal of Experimental Psychology, 1969, 81, 274-280.

Reynolds, M. C. A study of the relationships between auditory characteristics and specific silent reading abilities. Journal of Educational Research, 1953, 46, 439-449.

Rinsland, H. D. A basic vocabulary of elementary school children. New York: MacMillan, 1945.

Roswell, F. and Natchez, G. Reading disability: Diagnosis and treatment. New York: Basic Books, 1971.

Savin, H. B. What the child knows about speech when he starts to learn to read. In J. F. Kavanaugh and I. G. Mattingly (eds.), Language by ear and by eye. Cambridge, Mass.: MIT Press, 1972.

Schuckers, G. H., Shriner, T. H. and Daniloff, R. G. Auditory assembly of segmented sentences by children. Journal of Speech and Hearing Research, 1973, 16, 116-127.

Shriner, T. H. and Daniloff, R. G. Reassembly of segmented CVC syllables by children. Journal of Speech and Hearing Research, 1970, 13, 537-547.

Smith, E. E. and Spoehr, K. T. The perception of printed English: A theoretical perspective. In B. H. Kantowitz (ed.), Human information processing: Tutorials in performance and cognition. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1974.

Studdert-Kennedy, M. The perception of speech. In T. A. Sebeok (ed.), Linguistics and adjacent arts and sciences. Vol. 12. Current trends in linguistics. The Hague: Mouton, 1974.

Underwood, B. J. and Schulz, R. W. Meaningfulness and verbal learning. New York: Lippincott, 1960.

Van Riper, C. Speech correction principles and methods. (3rd. ed.) Englewood Cliffs, N. J.: Prentice-Hall, 1954.

Wheeler, D. D. Processes in word recognition. Cognitive Psychology, 1970, 1, 59-85.

Winitz, H. Articulatory acquisition. New York: Appleton-Century-Crofts, 1969.

Young, F. A. and Lindsley, D. B. (eds.). Early experiences and visual information processing in perceptual and reading disorders. Washington, D. C.: National Academy of Sciences, 1970.

## APPENDIX A

Stimulus List: CVCs

Stimulus List: CVCs

| | Visual | Auditory |
|---|---|---|
| 1. | bad | /bæ d/* |
| 2. | bag | /bæ g/ |
| 3. | ban | /bæ n/* |
| 4. | big | /bIg/ |
| 5. | bin | /bIn/* |
| 6. | chin | /tʃin/* |
| 7. | dad | /dæ d/* |
| 8. | dash | /dæ ʃ/* |
| 9. | dig | /dIg/ |
| 10. | dim | /dIm/ |
| 11. | dish | /dIʃ/ |
| 12. | gag | /gæ g/ |
| 13. | gash | /gæ ʃ/* |
| 14. | gum | /gʌm/ |
| 15. | gun | /gʌn/ |
| 16. | jam | /dʒæ m/* |
| 17. | led | /lɛd/* |
| 18. | leg | /lɛg/* |
| 19. | much | /mʌtʃ/ |
| 20. | rag | /ræ g/ |
| 21. | ram | /ræ m/* |
| 22. | ran | /ræ n/* |
| 23. | red | /rɛd/* |
| 24. | rich | /rItʃ/* |
| 25. | rub | /rʌb/ |
| 26. | run | /rʌn/ |
| 27. | sad | /sæ d/* |
| 28. | such | /sʌtʃ/ |
| 29. | sum | /sʌm/ |
| 30. | sun | /sʌn/ |

*Indicates a real-word VC segment

## APPENDIX B

Stimulus List: CVs

Stimulus List: CVs

| | Visual | Auditory |
|---|---|---|
| 1. | ba | /bæ / |
| 2. | bi | /bi/ |
| 3. | bu | /bʌ/* |
| 4. | cha | /tʃæ /* |
| 5. | che | /tʃɛ/* |
| 6. | chi | /tʃi/ |
| 7. | chu | /tʃʌ/* |
| 8. | da | /dæ / |
| 9. | di | /dI/ |
| 10. | ga | /gæ / |
| 11. | gu | /gʌ/ |
| 12. | ja | /dʒæ / |
| 13. | le | /lɛ/ |
| 14. | li | /lI/* |
| 15. | mi | /mI/* |
| 16. | mu | /mʌ/ |
| 17. | na | /næ /* |
| 18. | ne | /nɛ/* |
| 19. | ni | /nI/* |
| 20. | nu | /nʌ/* |
| 21. | ra | /ræ / |
| 22. | re | /rɛ/ |
| 23. | ri | /rI/ |
| 24. | ru | /rʌ/ |
| 25. | sa | /sæ / |
| 26. | se | /sɛ/* |
| 27. | sha | /ʃæ /* |
| 28. | shi | /ʃI/* |
| 29. | shu | /ʃʌ/* |
| 30. | su | /sʌ/ |

*Indicates syllable selected from a list of possible CV syllables not incorporated in CVC list.

## APPENDIX C

Stimulus List: VCs

Stimulus List: VCs

| | REAL WORD | | | NONSENSE | |
|---|---|---|---|---|---|
| | Visual | Auditory | | Visual | Auditory |
| 1. | ad | /æd/ | 16. | ab | /æb/* |
| 2. | am | /æm/ | 17. | ach | /ætʃ/* |
| 3. | an | /æn/ | 18. | ag | /æg/ |
| 4. | ash | /æʃ/ | 19. | esh | /ɛʃ/* |
| 5. | eb | /ɛb/* | 20. | ib | /Ib/* |
| 6. | ech | /ɛt /* | 21. | ig | /Ig/ |
| 7. | ed | /ɛd/ | 22. | im | /Im/ |
| 8. | eg | /ɛg/ | 23. | ish | /Iʃ/ |
| 9. | el | /ɛl/ | 24. | ub | /ʌb/ |
| 10. | em | /ɛm/* | 25. | uch | /ʌtʃ/ |
| 11. | es | /ɛs/* | 26. | ud | /ʌd/* |
| 12. | ich | /It / | 27. | ul | /ʌl/* |
| 13. | il | /Il/* | 28. | um | /ʌm/ |
| 14. | in | /In/ | 29. | un | /ʌn/ |
| 15. | us | /ʌs/* | 30. | ush | /ʌʃ/* |

*Indicates syllable selected from a list of possible VC syllables not incorporated in CVC list.

## APPENDIX D

Order of SOA and Syllable Type

Order of SOA and Syllable Type

| | Program I | | Program II | |
|---|---|---|---|---|
| Item Number | SOA (in msec) | Syllable Type | SOA (in msec) | Syllable Type |
| 1- 10 | 750 | C-V-C | 750 | V-C |
| 11- 20 | 500 | | 1000 | |
| 21- 30 | 1000 | | 500 | |
| 31- 40 | 1000 | V-C | 1000 | C-VC |
| 41- 50 | 750 | | 500 | |
| 51- 60 | 500 | | 750 | |
| 61- 70 | 500 | C-V | 750 | CV-C |
| 71- 80 | 750 | | 1000 | |
| 81- 90 | 1000 | | 500 | |
| 91-100 | 500 | C-VC | 500 | C-V-C |
| 101-110 | 750 | | 1000 | |
| 111-120 | 1000 | | 750 | |
| 121-130 | 750 | CV-C | 1000 | C-V |
| 131-140 | 1000 | | 750 | |
| 141-150 | 500 | | 500 | |